1.1 Data Distribution Thread Overview.

The Data Distribution Thread supports end-to-end data flow of FDs. It provides the mechanism for the system to move data values between most elements of the CLCS, which include the DDPs, CCPs, HCIs,and SDCs. It supports retrieval of FD data by user applications and user displays.

1.2 Data Distribution Thread Concept

The Data Distribution Thread spans from the point where data is received at the Data Distribution Processor (DDP) from the RTCN, to the point where data is retrieved by user applications and/or user displays. Data received from the RTCN include but are not limited to:

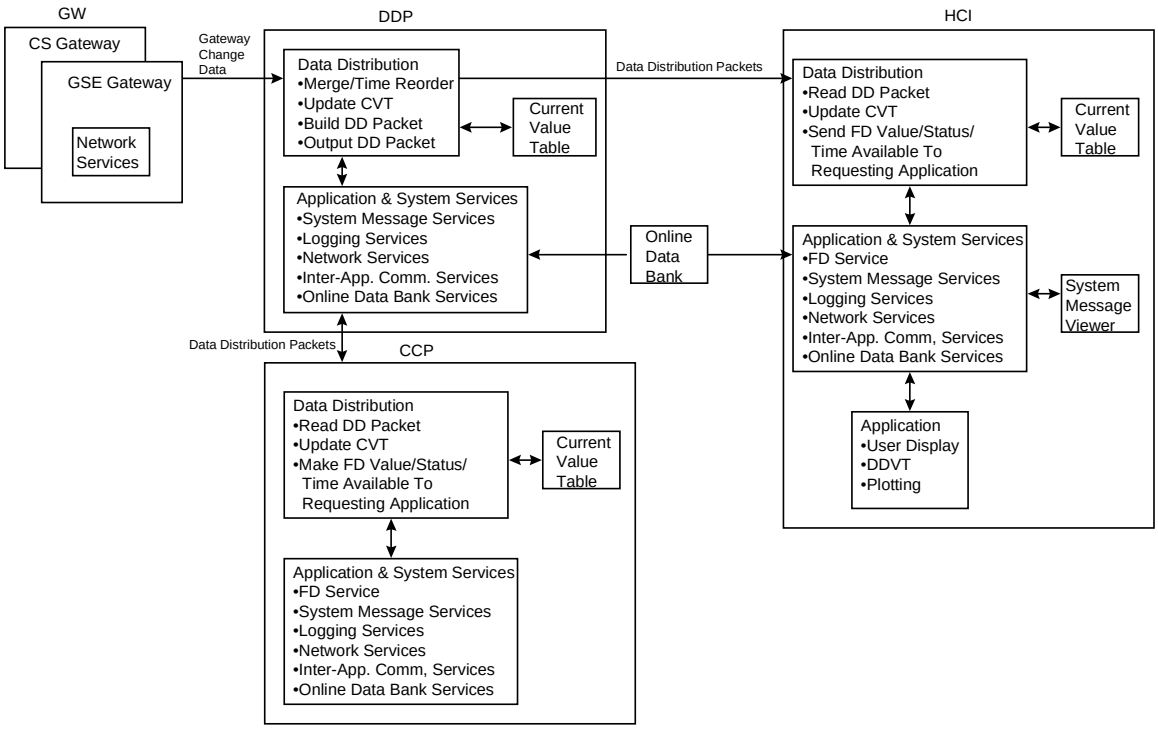
- Gateway change data
- Command data
- Application derived measurements

The data received is processed at the DDP. Processing includes merging and time re-ordering, performing data fusion, applying data health, adding display attributes, applying constraints checking, and finally outputting the data to RTCN at the system synchronous rate, and to the DCN at the display synchronous rate.

Part of the Data Distribution Thread runs in the Command and Control Processor (CCP), where data is read from the RTCN and made available to Command applications, and end-item managers on an FD parameter basis.

The end point of the Data Distribution Thread is at the HCI workstations, where FD can be retrieved by the user applications and/or user displays. Note that the processing in the CCP and HCI are very similar and should be driven by the same pieces of software. This end of the thread also consist of FD viewers, from which users will be able to view data values and attributes associated with one or more FDs.

Data Distribution and Processing Thread - Concept Diagram



1.3 Data Distribution Thread Specification

Following is the Statement of work for the Data Distribution Thread:

Statement of Work

- Provide performance data for system modeling.
- Confirm and or modify system data flow for FD Data Distribution.
- Provide the capability for the Data Distribution function to be utilized in both Operational and Application configurations.

DDP Data Merger Function

- Collect Gateway Change Data packets from all gateways at the system synchronous rate.
- Collect Application Change Data packets from all CCPs at System synchronous rate (*No Application Change Data packets until Thor Delivery*).
- Merge Gateway Change Data and Application Change Data in to a single a stream ordered to the nearest 0.1 ms. (*No Application Change Data until Thor Delivery*).
- Merge health data into data element from health table.
- Place requested FDs in queues for the Data Fusion Function.
- Place requested FDs in queues for the Data Health Function.
- Place requested FDs in queues for the Data Constraint Function (*Data Constraint Function is not part of Redstone Delivery*).
- Transmit this data at system synchronous rate on the RTCN.
- Transmit this data at display synchronous rate on the DCN.
- Define and provide a method to send System Default Display Data Attribute Values. (*A placeholder will be reserved in the CVT for default Display Data Attribute values. Setting mechanism will be defined for the Thor delivery*).
- Maintain statistics on packet rates, data rates, and CPU utilization.

CCP Data Function

- Collect RTCN Change Data Packets from the DDP at system synchronous rate.
- Place requested FDs in queues for System and User Application.
- Provide an output queue for user Application Derived FDs and transmits them to the DDP at system synchronous rate. (*No user Application Derived FDs to transmit in Redstone*).
- Maintain statistics on packet rates, data rates, and CPU utilization.

HCI Data Function

- Collect DCN Change Data Packets from the DDP at display synchronous rate.
- Place requested FDs in queues for System and User Application.
- Maintain statistics on packet rates, data rates, and CPU utilization.

SDC Data Function

- For debug use – Record raw Gateway Change Data Packets from all gateways and Application Change Data Packets from all CCPs on the RTCN. (*No Application Change Data Packets until Thor Delivery*).
- Record DDP RTCN Data Distribution Packets in a format to permit FD Retrievals. Note: For Redstone this may require the data conversion to CCMS format, to support current retrieval software. The purpose is not to develop final record retrieval function.

Current Value Table Function

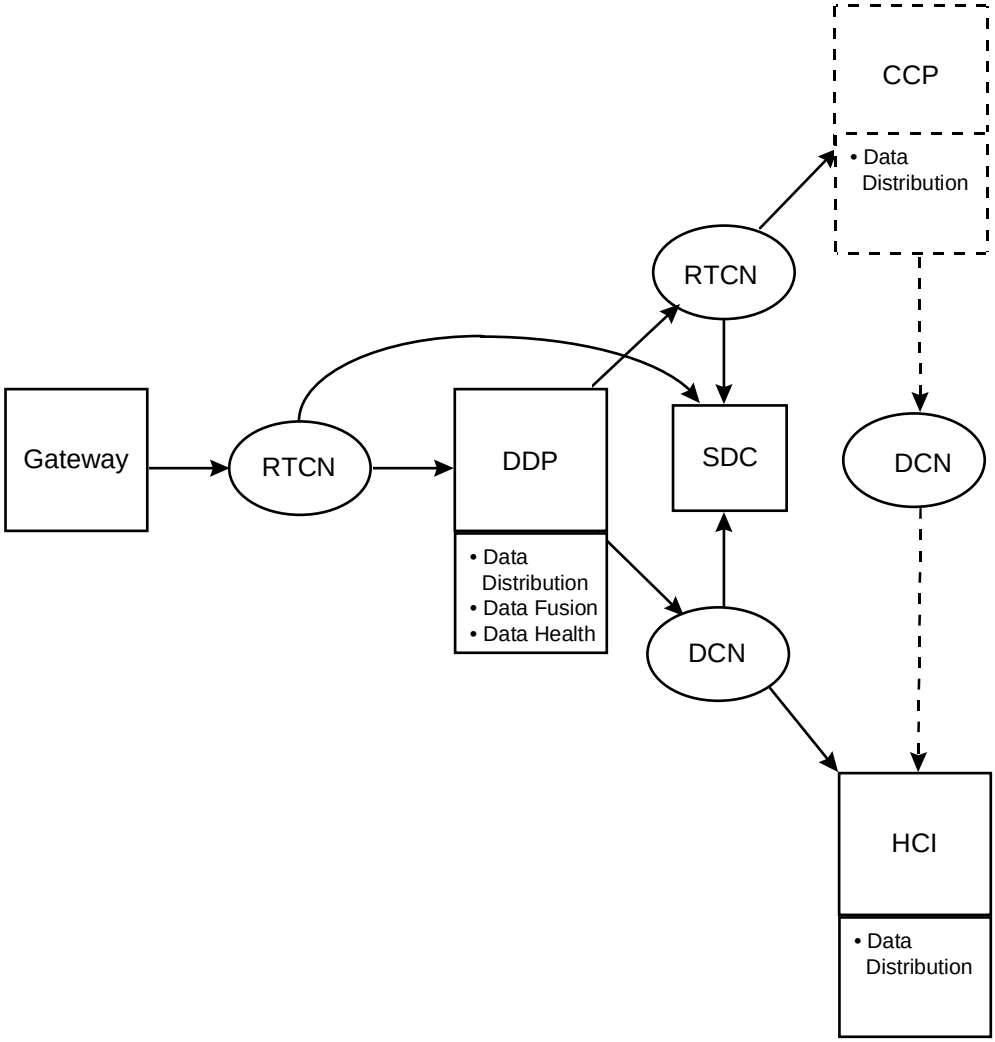
- Maintain in the DDPs, CCPs and HCIs a Current Value Table that contains for all FDs the current data value, its health and time of last change.
- Support all FD type including Time Homogenous and Multiword data.

- Provide separation of data for different flow zones. (Added during kickoff meeting)

1.4 Data Distribution Thread Assessment Summary

Number	CSCI/HWCI Name	CSCI Labor (Labor Month)	Redstone Labor (Labor month)	Base Cost Coverage
1	Data Distribution and Processing CSCI	90.0	63.0	
2	System Services	0	0	Reliable Messages Phase 2 Thread
3	Application Services	24.0	24.0	
4	System Viewers	0	0	User Display Monitor and Plotting thread
5	System Control	0	0	System Build and Load Thread
6	Consolidated System Gateway Services	3.8	3.8	System Build and Load Thread
7	GSE Gateway Services	0	0	GSE Support Phase 1 Thread
8	CLCS Development Environment	0	0	Covered by Facility Requirements
9	TCID Build & Control	0	0	Test Build, Load & Activation Thread
10	Data Bank	0	0	Test Build, Load & Activation Thread
11	Data Recording & Archival	6.0	4.5	
12	Data Retrieval	16.0	8.0	
	TOTAL	**139.8 mm**	**103.3 mm**	

1.5 Data Distribution Thread Hardware Diagram



1.6 Data Distribution Thread Deliverables

- Source code and executable software will be provided for the following:
  - Capability to receive, merge and time-order Change Data from the GSE and the CS gateway at the DDP
  - Capability to output the processed data as Data Distribution packets to RTCN and DCN
  - Capability to read in Data Distribution packets at the HCIs
  - Capability to deliver FD data to applications on a parameter basis via the Application interface
- Data Distribution API Manual
- Data Distribution User's Guide
- Data Distribution Design Specification

1.7 Data Distribution Thread Schedule

ID	Task Name	Start	Finish
	Data Distribution Thread Key Dates		
	Redstone Assessment Kickoff	2/26/97	2/28/97
	Concept Design Panel Internal Review	3/12/97	3/12/97

	Concept Design Panel	3/26/97	3/26/97
	Define Requirements for Redstone	3/17/97	4/25/97
	Identify and Resolve Dependencies	3/17/97	4/25/97
	Dependencies Resolved and Signed	5/02/97	5/02/97
	Requirement Design Panel Internal Review	5/02/97	5/02/97
	Requirement Design Panel	5/09/97	5/09/97
	Assess Cost and Prepare BOEs	3/27/97	4/28/97
	Detailed Design Panel Internal Review	5/23/97	5/23/97
	Detailed Design Panel	5/30/97	5/30/97
	Impacted CSCIs Development Integration Test	8/06/97	8/19/97
	Impacted CSCIs Formal Integration Test (CIT)	8/20/97	8/25/97
	Support System Integration Test	8/26/97	9/30/97
	Data Distribution Thread Redstone Development Complete	9/30/97	9/30/97

ID	CSCI Name	Key Dependencies	Need Date	Available Date
1	N/A	Redstone Payload Packet IDD	4/30/97	
2	N/A	SDE-H Redstone Environment @ Houston	4/30/97	
3	Application Services	API Definition (Preliminary) ■ FD Services ■ Online Data Bank Access Services ■ Logging Services ■ System Message Services ■ Inter-Application Communication Services	4/30/97	
4	Application Services	API Definition of above list (Final)	5/30/97	
5	System Services	Network Services Read design finalized	5/30/97	
6	System Control	TCID Descriptive Qualifier API definition (Prelim)	4/30/97	
7	System Control	TCID Descriptive Qualifier API definition (Final)	5/30/97	
8	System Services	Network Services Library @ Houston	6/16/97	
9	Application Services	Following Services Library @ Houston ■ Online Data Bank Access Services ■ Logging Services ■ System Message Services ■ Inter-Application Communication Services	6/16/97	
10	CS GW Services	Capability to output CS data with repeatable pattern @ Houston	6/16/97	
11	TCID Build & Control	TCID available @ Houston	7/07/97	
12	RTPS Sys SW Build	System Build Capability	7/07/97	
13	System Control	Load & Init application Capability @ Houston	8/04/97	
14	System Control	Capability to load TCID products @ Houston	8/04/97	
15	System Viewers	FD Viewers & FD Monitor @ Houston	8/04/97	
16	(SE Performance personnel)	Performance Evaluation - Develop models, give timing and resource estimates and collect actual measurements provided by the Data Distribution CSCI team.	8/04/97	
17	Recording, Archive and Retrieval	Capability to record and retrieve packet and FD and at KSC	08/18/97	

1.8 Data Distribution Simulation Requirements

The Simulation Requirements for Data Distribution are listed below:

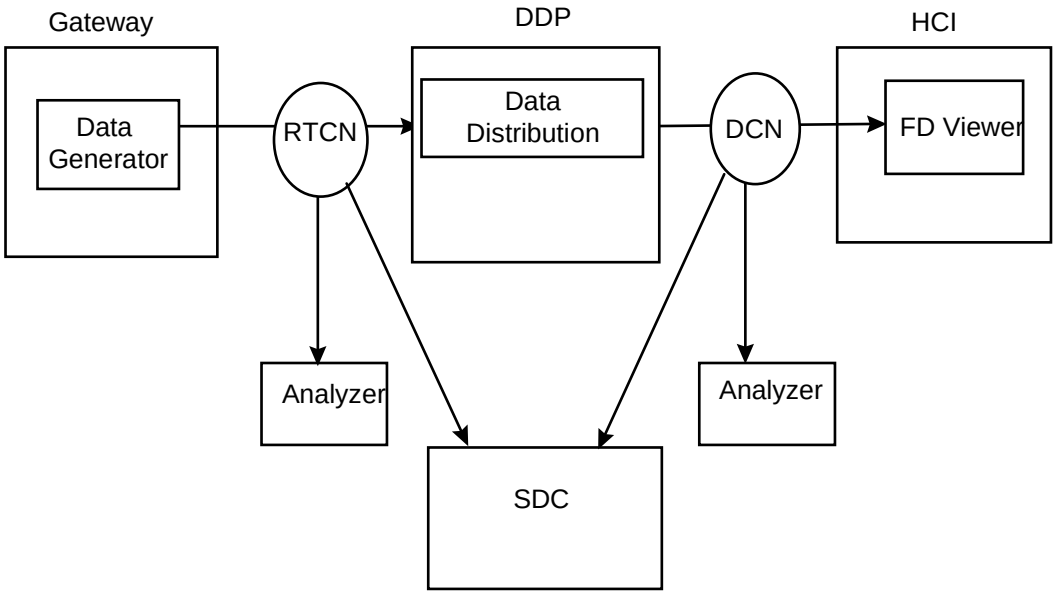
- A test driver shall be provided to simulate CS Gateway inputs in the absence of the final GSE Gateway software for remote UIT purposes.
- A canned set of data will be used as input to the test driver for verification purposes during UIT.

1.9 Data Distribution Thread System Test Requirements

Data Distribution end-to-end development testing will be performed prior to start of System Test:

- Data Generator provided by the CS and GSE Gateway will be used to generate a predefined and representative set of FD values/statuses. Rotational patterns will be used for variations.
- LAN analyzer will be used on the Network to track data rates.
- FD viewers will be used to visually verify FD data received at the HCIs.
- SDC recorded data will be used to verify FD data sent and received across the Network.
- Messages written to DDP local log and System messages sent to the HCIs will be used for debug and verification purposes.

System test plan and test procedures will be prepared by the System Test Organization.



1.10 Data Distribution Thread Training Requirements

The following training will be provided by Thread personnel:

- A presentation to the user on the usage of the APIs supplied by FD Services.

Vendor training will be needed by the developers:

- Training on target CM tool
- Training on target Development tools

Additional training needed by the developers:

- Online Data Bank usage from Online Data Bank personnel
- CS data generator usage from Gateway engineer(s).

1.11 Data Distribution Facilities Requirements

The following facility resources will be required by Data Distribution for Redstone software development and testing (off-site testing at Houston and on-site testing at KSC) purpose:

	SDE-H	SDE-1	IDE	OPS
ATM Network	2			
Gateway Platform	1	1	1	1
DDP Platform	1	1	1	1
CCP Platform	0	1	1	1
HCI Platform	13	3	3	3
PC (486, 66 MHZ)	2			
3-COM or SMC card	1			
Winframe Server	1			
CM Server	1			
Target Development Tool	15 licenses			
Target CM Tool	15 licenses			
Remote link from SDE-H to SDE -1	1	N/A	N/A	N/A

The full GSE Support Thread SDE/IDE platform and network configuration as well as the Application Debug Thread configuration is required for Data Distribution Thread Integration and Operational Testing.

1.12 Data Distribution Procurement

- All hardware items and development tools needed by Data Distribution will be provided as facility resources and no separate procurement will be needed from Data Distribution.

1.13 Data Distribution Dependencies

The following CSCIs were identified as being impacted or required by the Data Distribution Thread (Note - More detailed dependencies are listed in the Data Distribution Thread schedule in section 1.7):

Number	CSCI/HWCI Name	CSCI/HWCI
1	Data Distribution and Processing CSCI	CSCI
2	System Services	CSCI
3	Application Services	CSCI
4	System Viewers	CSCI
5	System Control	CSCI
6	System Diagnostics	CSCI
7	Consolidated System Gateway Services	CSCI
8	GSE Gateway Services	CSCI
9	CLCS Development Environment	CSCI
10	TCID Build & Control	CSCI
11	Data Bank	CSCI
12	Data Recording & Archival	CSCI
13	Data Retrieval	CSCI
14	Training	(Vendor and Thread personnel)
15	SDE-H, SDE-1, SDE-2 and IDE	(Facility and HWCI)
16	Performance Evaluation Support	(SE Performance group)

1.14 Data Distribution Action Items/Resolution

- The RTCN payload packets data format/layout needs to be finalized and documented.
- The TCID product format/layout needs to be defined and documented.
- Status bits and ownership need to be defined:
- The System Build and TCID Build process and procedures need to be defined.
- The OPS concept on Flow Zone and activity definition need to be developed.
- Network Design needs to be resolved, especially redundancy considerations. Currently Data Distribution assumes the following:
    - No data will be dropped via the use of Reliable Messages capability.
    - Data Distribution will not request a re-send of data from its data source.

2. CI Assessments

2.1 Data Distribution Processing CSCI Assessment

General Work Required

- Confirm and or modify system data flow for FD Data Distribution
- Provide the capability for the Data Distribution function to be utilized in both Operational and Application Debug Configurations.

DDP Data Merge and Re-ordering Function Work Required

- Collect the Gateway Change Data Packets from all gateways at the system synchronous rate.
- Collect Application Change Data Packets from all CCPs at system synchronous rate.
    - ***Application Change Data Packets from CCPs will not be available for Redstone.***
- Merge Gateway Change Data and Application Change Data in to a single data stream ordered to the nearest 0.1 ms.
    - ***Application Change Data Packets from CCPs will not be available for Redstone.***
- Merge health data into data element from health table.
- Place requested FDs in queues for the Data Fusion Function.
- Place requested FDs in queues for the Data Health Function.
- Place requested FDs in queues for the Data Constraint Function.
    - ***Data Constraint Function will not be implemented in Redstone.***
- Transmit this data at system synchronous rate on the RTCN.
- Transmit this data at display synchronous rate on the DCN.
- Define and provide a method to send System Default Display Data Attributes Values**..**
- Maintain statistics on packet rates, data rates, and CPU utilization
- Collect and process only the FD data belonging to the DDP configured Flow Zone and activity.

CCP Data Function Work Required

- Collect RTCN Change Data Packets from the DDP at system synchronous rate.
- Place requested FDs in queues for System and User Applications.
- Provide the output queue for User Application Derived FDs and transmit them to the DDP at system synchronous rate.
    - ***There will not be any User Application Derived FDs in Redstone.***
- Maintain statistics on packet rates, data rates, and CPU utilization.
- Collect and process only the FD data belonging to the CCP configured Flow Zone and activity.

HCI Data Function Work Required

- Collect DCN Change Data Packets from the DDP at display synchronous rate.

- Place requested FDs in queues for System and User Applications.
- Maintain statistics on packet rates, data rates, and CPU utilization.
- Collect and process only the FDs data belonging to the HCI configured Flow Zone and activity.

Current Value Table Function Work Required

- Maintain in the DDPs, CCPs and HCIs a Current Value Table that contains, for all FDs, the current data value, its health and time of last update.

- Support all FD type including Time Homogenous and Multiword data.

The following **Data Fusion CSC** functions will be provided in support of the Data Distribution Thread:

Data Fusion Work Required

- Provide the capability for Fused FD's to be available to the Data Distribution Manager for distribution to both the CCP and the HCI. (***Thor Delivery***)
- Incorporate Fused FD's into the record and retrieve CSCI with the same capabilities as Gateway FD's and User Application Derived FD's. (***Thor Delivery***)

The following Data Health CSCI capabilities will be provided in support of the Data Distribution Thread:

Data Health Work Required

- Incorporate Data Health information into Data Distribution.

Data Distribution Processing CSCI Assessment (Based on partial reuse of Juno software)

Function Name	CSCI Labor (EP)	% of CSCI	Function EP
DDP Data Merge & Time Re-ordering	36.0 mm		30.0 mm
Update Current Value Table	12.0 mm		12.0 mm
Build and Output Data Distribution Packets	12.0 mm		12.0 mm
Read Data Distribution Packets @ HCI/CCP	6.0 mm		3.0 mm
Incorporate Data Fusion	6.0 mm		3.0 mm
Incorporate Data Health	6.0 mm		3.0 mm
Performance Enhancements	12.0 mm		0
TOTAL	90 mm		63 mm

Lines of Code

25,000 SLOC

Documentation

The following documentation will be provided:
- Data Distribution Design Specification
- Data Distribution User's Guide

Assumptions

Refer to the list of open issues listed under Data Distribution Action Items/Resolution in section 1.12.

Open Issue

Refer to the list of open issues listed under Data Distribution Action Items/Resolution in section 1.12.

2.2 System Services CSCI Assessment

The following System Services CSCI capabilities will be provided in support of the Data Distribution Thread:

Operating System Task Priority Definition Support Required

- The Operating System shall allow task priorities to be defined.
- The Operating System shall allow processes to be assigned to and locked into a specified CPU on a multi-processor machine.
- The Operating System shall be able to support monitoring and recording CPU utilization on a process basis.

Network Services CSC Work Required

- Support definition of data stream identifiers for unique identification of data stream. (to be used by all data stream reading and writing applications.)
- The data stream identifiers shall be such defined, so that Flow Zone data separation can be supported via the use of the naming convention.
- Provide a mechanism to support point-to-point data separation between different Flow Zones.
- Provide the capability to support Real time Data Transfer Statistics to maintain statistics on DDP/CCP/HCI packet/data rates.
- Support of Application Services API implementation.

CSCI Assessment

The cost and assessments will be provided by the Reliable Message Phase 2 Thread.

Lines of Code

TBD

Documentation

TBD

Assumptions

TBD

Open Issue

TBD

2.3 Application Services and Tools CSCI Assessment

The following capabilities will be provided by the Application Services CSCI in support of the Data Distribution Thread:

FD Services Work Required

- Provide a set of APIs that allows applications to access FD data values and statuses.

Online Data Bank Services Work Required

- Provide an application interface that allows applications to retrieve FD data items from the Online Data Bank.

Inter-Application Communications Work Required

- Provide a location transparency mechanism for Data Distribution to be utilized in both Operational and Application Debug Configurations.

Data Logging Work Required

- Provide the capability that allows applications to write messages to a workstation log.
- Provide the capability to create a local log to store logged messages.

Log Retrieval Work Required

- Provide a interface that allows users to initiate retrieval of logged information from the local workstation log.
- Provide the capability that allows users to initiate retrieval of logged information from a remote workstation via a graphical user interface.
- Provide a mechanism to differentiate log retrieval from a local disk at a workstation from retrieval from the SDC.

System Message CSC Work Required

- Provide the capability that allows applications to send a text advisory message to a System Message GUI which can reside either a local HCI or at a remote HCI.

CSCI Assessment

Function Name	CSCI Labor (EP)	% of CSCI	Function EP
FD Services Function	24 mm	100	24 mm
Online Data Bank Services Function	Covered by the User Display Monitor Thread		
Inter-Application Communications	Covered by the Reliable Message thread		
Logging Function	Covered by the Reliable Message Thread		
Initiate retrieval from a remote workstation	Covered by the Reliable Message Thread		
System Messages	Covered by the Reliable Message Thread and the User Display Monitor Thread.		

Lines of Code

TBD

Documentation

TBD

Assumptions

TBD

Open Issues

TBD

2.4 System Viewers CSCI Assessment

The following capabilities will be provided by the System Viewers CSCI in support of the Data Distribution Thread:

System Viewers Work Required

- Provide FD Viewer
- Provide FD Monitor
- System Message Viewer

CSCI Assessment

The cost assessment for this CSCI is being provided in the User Display Monitor and Plotting Thread.

Documentation

Refer to the User Monitor and Plotting Thread Assessment package.

Assumptions

Refer to the User Monitor and Plotting Thread Assessment package.

2.5 System Control CSCI Assessment

The following capabilities will be provided by the System Control CSCI in support of the Data Distribution Thread:

OPS Configuration Manager CSC Work Required

The following requirements will be implemented:

- Provide the capability to load and initialize data distribution applications.
- Provide an API to a table of TCID descriptive qualifiers (e.g. Test name, vehicle, etc.).
- Provide TCID products, including data distribution products on DDP, CCP and HCI platforms.

CSCI Assessment

The cost assessment for this CSCI is being provided in the Test Build, Load & Activation Phase 1 Thread. .

Documentation

Refer to the Test Build, Load & Activation Phase 1 Thread.

Assumptions

Refer to the Test Build, Load & Activation Phase 1 Thread.

2.6 TCID Build & Control CSCI Assessment

The following capabilities will be provided by the TCID Build and Control CSCI in support of the Data Distribution Thread:

Table Build Work Required

- Provide the capability to build TCIDs which will consist of all supported FD information.
- Provide the capability to store all FD information at the Online Data Bank.

CSCI Assessment

The cost assessment for this CSCI is being provided in the Test Build, Load & Activation Phase 1 Thread.

Lines of Code

Refer to the Test Build, Load & Activation Phase 1 Thread assessment package.

Documentation

Refer to the Test Build, Load & Activation Phase 1 Thread assessment package.

Assumptions

Refer to the Test Build, Load & Activation Phase 1 Thread assessment package.

Open Issues

Refer to the Test Build, Load & Activation Phase 1 Thread assessment package.

2.7 RTPS System Software Build CSCI Assessment

Function System Software Build Work Required

- Provide the capability to build system software to be placed under configuration control.

CSCI Assessment

The cost assessment for this CSCI is being provided by the System Build & Load Phase 1 Thread. .

Documentation

Refer to the System Build & Load Phase 1 Thread.

Assumptions

Refer to the System Build & Load Phase 1 Thread.

2.8 Data Recording & Archival CSCI Assessment

Function Data Recording and Archival Work Required

Software will be written to run in the SDC. This software will process packets from all network interfaces attached to CLCS. The software will merge the payload types from the Real Time Critical Network and the Display and Control Network into data files suitable for retrieval. During this process the payload data from each network will be stored and made available for retrieval. This data will be stored in the SDC. The processed data files shall be archived to tape at some point when the space is needed. The recording console will be modified to indicate which CLCS data streams are available for recording and be able to initialize recording. The data will be indexed by time and FDID or time and type (ie. CtoC, message, dump data, etc.)

CSCI Assessment

Function Name	CSCI Labor (EP)	% of CSCI	Function EP

Recording and Archival	6 mm	75	4.5 mm

Lines of Code

TBD.

Documentation

Normal SDC development documentation will be produced as part of the Data Recording development.

Assumptions

FDs will be restricted to those data types supported by the CCMS Databank.

The data will only be recorded in the lab.

Open Issues

- The CLCS packet format

The network architecture from CLCS into the SDC.
- TBD

2.9 Data Retrieval CSCI Assessment

The following capabilities will be provided by Data Recording & Archival in support of the Data Distribution Thread:

Function Data Retrieval Work Required

The retrieval subsystem on the SDC will be modified to retrieve data from the CLCS Payload Data. New software will be written to read and format the data contained in each of the files. The raw packets will be retrieved by type using the dump application written in the JUNO release. This application will be modified to use the new retrieval routines. The existing DAP applications will be utilized to retrieve the change data. A binary socket level interface and associated API will also be developed to allow CLCS developers to have access to the recorded serial packet data from the program level.

CSCI Assessment

Function Name	CSCI Labor (EP)	% of CSCI	Function EP
Data Retrieval	16 mm	50	8mm

Lines of Code

TBD.

Documentation

Normal SDC development documentation will be produced as part of the Data Retrieval development.

Assumptions

FDs will be restricted to those data types supported by the CCMS DBSafe.

The FDID will be 16 bits for Redstone (18 bits truncated to 16 bits).

Only FD change data from CLCS Packet Payload Type 2 can be retrieved without status while using the existing DAP Applications.

Time returned with data will be limited to millisecond resolution (ie. Not the 100 microsecond delta time).

The data returned will be returned without health information. If health information is required for Redstone, it can be obtained from the Juno capability for packet retrieval.

Open Issues

None.

Note:

It is anticipated that the following CAP Applications will be available for the Redstone release:

CAP104 List Change
others TBD

These CAP Application are being migrated as part of the CDS to SDC migration effort and are not part of this assessment.

2.10 GSE Gateway CSCI Assessment

The following capabilities will be provided by the GSE Gateway CSCI in support of the Data Distribution Thread:

GSE Gateway Simulator Work Required

- Provide a test data generator that uses a canned set of data to generate GSE Change Data Packet and output to the RTCN.
- Test data generator can be executed either on a Gateway platform or as part of the CLCS DDP group.

CSCI Assessment

Function Name	CSCI Labor (EP)	% of CSCI	Function EP
Test Data Generator			3.8 mm

Lines of Code

Refer to the GSE Support Phase 1 Thread assessment package.

Documentation

Refer to the GSE Support Phase 1 Thread assessment package.

Assumptions

Refer to the GSE Support Phase 1 Thread assessment package.

Open Issues

Refer to the GSE Support Phase 1 Thread assessment package.

3. COTS Products Dependencies

3.1 SW Products Dependency List

Pending market survey, COTs product for Data Fusion and Data Health may be utilized.

3.2 HW Products Dependency List

Gateway, DDP, CCP, HCI and Network hardware dependencies are covered under the Data Distribution Facility Requirements in section 1.11.